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PILOT FATIGUE IN SHORT-HAUL OPERATIONS: EFFECTS OF DUTY ASSIGNMENT, WORKING ENVIRONMENT, STRESS, AND ILLNESS

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Abstract. Fatigue is very critical in the aviation sector due to it affects many passengers' safety. However, there is a little research on what factors are associated with fatigue in short-haul pilots. The purpose of this study is to analyze factors that affect airline pilots of Boeing 737 fleet of Garuda Indonesia, which fly domestic and regional flights. Fatigue is defined as physical decline. Online survey by using questionnaires reached 234 returned samples. The results of this study show that pilot fatigue is affected by duty assignment, working environment, unresolved stress, and illness. These findings can contribute to reducing and managing pilot fatigue.

Keywords: Fatigue, Physical Decline, Airline Pilot, Risk Management, Operation, Human Factors

INTRODUCTION

Over the last two decades, human factors are identified as one of the potentials to compromise the safe operation of the flight, while fatigue has been identified as a causal factor (Roach et al., 2012). Human factors are recognized as one of the critical determinants for managing and improving flight safety (NASA, 1999). The "Swiss cheese" model of human error, by James Reason, describes four levels of human failure, each influencing the next. The unsafe acts of pilots can be directly linked to nearly 80% of all aviation accidents, while one of the principal subdivisions of unsafe aircrew conditions were developed substandard conditions of the pilots, including adverse mental/ physiological states, and physical/ mental limitation (Shappell & Wiegmann, 2000). Fatigue, subjective or physiological, consider as a substandard condition, which degrades a person's ability to stay awake, alert, and attentive to the demands of controlling their vehicle safely; also, fatigue impairs our ability to judge just how fatigued we are (NTSB, 2016).

It is critical that fatigue countermeasures be available to help combat the often overwhelming effects of sleep loss or sleep disruption, as pilots commonly associated the cause with frequent changes in Duty Assignments, including early morning flights, successive early wake-up, late night flight arrivals, and overnight flight (FAA, 2012; Goode, 2003; Hartzler, 2013; Lee & Kim, 2018; Liao, 2015); Working Environment, which includes, vibration through aircraft seats, air pressure change, oxygen level, humidity, and air temperature fluctuation (Ciloglu et al., 2015; Dawson & McCulloch, 2005; Maier & Marggraf-Micheel, 2015; Vink et al., 2012); Unresolved Stress, including personal problems and family matters (CAA, 2014; Reinhart, 2007); and illness (Davies, 2016; Reinhart, 2007).

This research aims to identify factors that contribute to pilot fatigue which existed in Garuda Indonesia's Boeing 737 fleet flight operations, which is the suitable and popular type for short-haul flight operation and determine which contributing factors have the more or the least significant impact on pilot fatigue. Sufficient information about fatigue contributors for flight crew will be beneficial for flight operations and planning, both for operators and regulator.

This research uses factors analysis to reduce the dimension and linear regression analysis to determine how independent variable affects the dependent variable. Pilot's perception towards potential fatigue significant contributors which affect the short-haul flight operation collected through questionnaire, as the main data source for this research.

LITERATURE REVIEW

Attributing accidents solely to pilot error is like a medical doctor telling the patient that they are "sick" without examining the causes of further defining the illness (Shappell & Wiegmann, 2000). To understand more about human error, it must be familiar with human factors. Human Factors will impact two broad areas of the system's effectiveness; safety and efficiency, and the well-being of operational personnel which jointly interrelated overlap and affect each other (ICAO, 1998). The unsafe, or substandard, aircrew conditions are identified as adverse mental states, adverse physiological states and physical/ mental limitations (Shappell & Wiegmann, 2000).

The subject of discourse and research has long been Fatigue, its causes, mechanisms and consequences. Fatigue is easily recognized as a condition of results in which you feel weary or sleepy (Lee & Kim, 2018). There are numerous discussions among and within the many disciplines involved but no definition has been agreed (Noy et al., 2011). Although it is significant for safety and health, there has been a lengthy historical debate on how fatigue in human transport operators should be operationalized (Phillips, 2015).

The Oxford dictionary defines fatigue as extreme tiredness resulting from mental or physical exertion or illness (Oxford, 2013). Fatigue is a psychophysiological disorder induced by exercise that is suboptimal. The degree and aspect of the situation rely on the shape and exercise background. Fatigue shifts strategies, policies or the use of resources (Phillips, 2015). NASA describes it as tiredness, sleepiness or exhaustion (NASA, 1999).

It will be useful to identify fatigue contributors to reduce the risk of fatigue. The regular work for pilots is dynamic shifting tasks, several start-ups and flights, early departures and the daytime journey within a prescribed time boundaries (Thomas et al., 2015). Pilot duty schedule affect the pilot performance and risk of safety. Pilot job factors can, for instance, be seen to show how they influence alarming team members, how alertness impacts team efficiency in various working loads and operating conditions and how pilot work and alertness combine to influence security efficiency, evaluated by incident or accident events. The connection between duty scheduling and pilot performance is complicated (Goode, 2003).

Pilots uses more physical ability, since they are subject to different pressures and unique physical settings (Lee & Kim, 2018). In addition pilots must continuously pay attention to the automatic digital instruments, requiring considerable focus and strain (Dawson et al., 2014). Environment of fluctuating air pressure, fluctuating temperature, bad weather, noise and vibration has become their daily working habitat (Maier & Marggraf-Micheel, 2015; Rood & James, 2016; Vink et al., 2012).

Pilots have social life which have to be maintained to keep their mental health state, hence, problems with family, significant others and social needs are inevitable (Bor et al., 2002). An effect of occupational and domestic stress, along with life events and work discontent management strategies, mental health and performance among pilots of commercial airline companies, shows that overall mental ill health was associated with a lack of autonomy, fatigue and flying patterns, and with a lack of relaxation and social support in general (Cooper & Sloan, 1985; Widyahening, 2007).

Some pilot may perceive some illness as prevalent, such as common cold, well managed allergies and obstructive sleep apnea which have significant contribution tuwards fatigue when relapse (Reinhart, 2007). Different health issues can influence sleep quality and quantity. Obstructive sleep apnea or certain medication, restless limb syndrome, anxiety, chronic pain, insomnia and pressure include other health circumstances or medical situations (Salazar & Caldwell, 2010)

Fatigue is recognized as a familiar sensation that is caused by a variety of activities associated with daily life while also as one of the significant factors that can impair human performance and has been cited as a cause of accidents and incidents in the transport industry, including air transport (Lee & Kim, 2018). One dimension of fatigue is Physical Decline (Dawson & McCulloch, 2005; Dinges et al., 1996). Physical fatigue is caused by more than just one muscle being unable to perform. During physical activity, the onset of muscle fatigue is gradual and depends upon an individual's level of physical fitness, and other factors, including sleep deprivation and overall level of healthiness. Proper rest can reverse this process. A lack of energy in the muscles causes the physical fatigue by reducing the drive originating from the central nervous system or by decreasing the efficiency of the neuromuscular junction (Wesensten et al., 2001).

Research model as depicted in Figure 1 is constructed based on the literature review analysis and modified from the model developed by Lee and Kim (2018) by not including the flight direction, since the nature of short-haul flight operations, merge the crew scheduling and partnership in one variable of duty assignment (Goode, 2003), maintain the variable of working environment, and add two variables, which are unresolved stress, which includes differences of values between working partners, household tension, preoccupation and personal problems; and illness, which includes managed allergies and perceived unfit condition (Reinhart, 2007; Widyahening, 2007).

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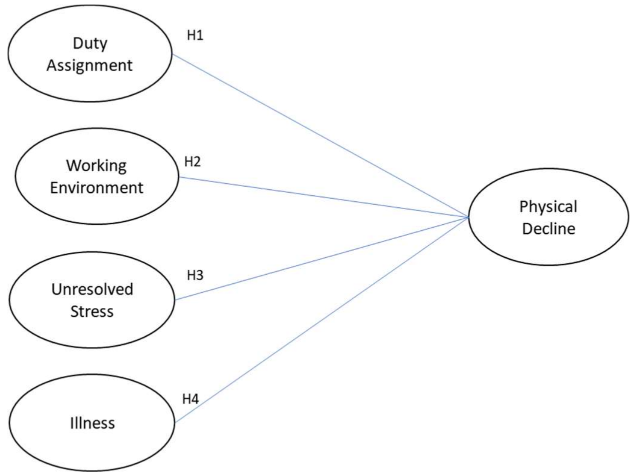

Figure 1. Research Model

METHODOLOGY

Based on the literature review, preliminary interview conducted towards seven SMEs consists of five active Garuda Indonesia Pilots and two of Garuda Indonesia's in-house Flight Surgeon Medical Doctors to elicit practical experiences and opinions.

Online survey to Garuda Indonesia's B737 pilots conducts afterward, and the result analyses to find out which factor contributes a more significant effect than the other. The above contributing factors may be perceived differently in the flight operation's workload, which makes short-haul flight operation fatigue perception is different compared to long- haul flight operation. While most of the fatigue research analyses the long-haul flights, this research will concentrate on short-haul flight operations.

The data collected through electronic survey. The survey circulated to 600 pilots, and 236 responses collected (Taherdoost, 2016). The statistical analysis then conducted using IBM SPSS 20. The validity test of the date uses factor analysis, to identify and reduce uncorrelated items (Usman & Sobari, 2013). After reliability test and classical assumption test conducted, it is assured that the data considered as fit for regression analysis.

RESULTS AND DISCUSSION

The gathered data was tested to determine whether it is suitable for factor analysis. Methods used are: The Bartlett test of sphericity, to check the correlation of each variable, Kaiser Mayer Olkin (KOM) test, which value of 0.05 or above is deemed acceptable to continue the factor analysis, and Measure of Sampling Adequacy (MSA), a value of more than 0.5 means that the variable can be predicted by other variables (Usman & Sobari, 2013). Reliability check also performs, as Cronbach's alpha assesses how well the items in a set are positively correlated with one another, it was used to test the internal consistency (Lee & Kim, 2018). Cronbach alpha with values of 0.60 deemed the lower limit of acceptability (Hair et al., 2013). Validity (Factor Analysis) and Reliability Tests are as depicted in Table 1. It is confirmed by Factor Analysis, that Physical Decline Contributors are categorized as Duty Assignment, Working Environment, Unresolved Stress, and Illness.

Table 1. Factor Analysis Results

	DA	WE	US	IL	PD
DA1	0.843				
DA2	0.813				
DA3	0.744				
DA5	0.734				
WE2		0.720			
WE3		0.826			
WE4		0.837			
WE5		0.830			

WE6		0.790			
US1 US2 US3 US4			0.879 0.907 0.819 0.778		
IL1 IL2 IL3				0.809 0.862 0.811	
PD1 PD2 PD3					0.860 0.898 0.721
Cronbach's Alpha	0.794	0.860	0.868	0.770	0.763

The proposed model and hypothsized path were tested on regression analysis. Multiple regression analysis carried out in terms of physical decline and the results are depicted on Table 2:

Table 2. Regression Analysis

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	12.835	.140		91.606	.000		
	FAC_DA	.456	.159	.172	2.866	.005	.778	1.285
	FAC_WE	.331	.156	.125	2.118	.035	.807	1.239
	FAC_US	.792	.163	.299	4.856	.000	.740	1.351
	FAC_IL	.562	.157	.212	3.570	.000	.796	1.256

a. Dependent Variable: PD

The result from Regression Analysis shows that all independent variables; Duty Assignment, Working Environment, Unresolved Stress, and Illness contributes significantly positive towards Physical Decline of pilots. The highest contribution is by Unresolved Stress, and the lowest is by Working Environment.

The result supports the regarding pilot's duty assignment, working environment, unresolved stress and illness background theories. It is shown in the result that is none of the independent variables have other than positive effect towards physical decline.

Duty assignment deemed as the professional workload but also a productive driver for pilots, which fully managed by the airline company. Work environment, on the other hand, is the nature of the job, with addition of several outside controlled influences, e.g. aircraft condition, and as the side impact of duty assignment, e.g. duty partner.

Airline company has limited access to manage unresolved stress, only job assignment related factors can be managed by the company, however, household tensions and other domestic problems are more personal. Illness is also personal matters, however, if the problems shared properly with the medical expert, they are possible to be anticipated and managed.

CONCLUSION

From the above results it can be concluded that Duty Assignment, Working Environment, Unresolved Stress, and Illness have significant effects on Physical Fatigue. Duty Assignment considered as the primary source of professional workload and a driver for Pilots to be productive. Working Environment of Pilots is believed as physically challenging and experienced as one of the fatigue contributors. Unresolved Stress already impairs the physical and mental capacity even before Pilots exposed towards their activity. For Pilots who perceived themselves as quite fit, while actually not fit, will experience more physical decline perception than those who are really fit.

The contributors of Pilot's Physical Decline can be classified into: Perconal/Internal and External. The Personal matters are considered as Human Performance Limitation and the external matters are considered as threat or sub-standard environment (CAA, 2014; Shappell & Wiegmann, 2000). Personal matters includes the variables of Unresolved Stress and Illness, while external matters are Duty Assignment and Working Environment.

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It is concluded, pilot's stress of mental health has a significant effect towards physical performance, and should be maintained as well as pilot's physiological condition. Duties and Work Environment, although lower contribution, also have to be well managed, since the contribution towards Physical Decline is obviously significant.

Regular counselling practice is recommended to be regularly conducted by airline operator to maintain mental health for their pilots, as well as regular medical check-up. The balance between rest and duty have to be well managed, to give opportunity for pilots, not only to replenish their physiological needs, but also their social and mental needs.

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